PORTABLE HEMMING APPARATUS AND METHOD

CROSS REFERENCE TO RELATED APPLICATION

This application claims the priority of provisional application 60/392,016 filed June 26, 2002.

TECHNICAL FIELD

This invention relates to the field of hemming one or more performed metal panels together to form a hemmed joint or closed panel, and more particularly to an improved apparatus and method for completing the hemming procedure.

BACKGROUND OF THE INVENTION

It is known in the art relating to hemming to use a conventional press structure as the hemming device. It is also known to transport the metal panels to be hemmed to the hemming device itself. This is undesirable because it is difficult to interchange hemming devices to hem different types of metal panels and because the panels must be moved directly into the hemming device. It is further a newly known method of hemming to recognize a set of metal panels (a "workpiece") and to move a corresponding hemming die to the workpiece. This is an improvement over the conventional method, but still fails to solve the problem that hemming devices

are large, heavy, difficult to move, difficult to change with regards to the hemming die, and expensive to produce and maintain.

SUMMARY OF THE INVENTION

The present invention provides a portable hemming apparatus for performing both hemming and pre-hemming of metal panels on a final assembly line or a pre-assembly work cell. The hemming apparatus has the advantage of being more compact in size, lightweight, and portable than other similar apparatus. Thus, the present hemming apparatus can be transported to metal panels by mounting it to a robot, hanging it from a manually operated tool balancer, or integrating it into other tooling to act as a secondary operation. The portability of the hemming apparatus allows it to be integrated into a final assembly line or a pre-assembly work cell. Alternatively, the hemming apparatus can be mounted on a pedestal stand or other similar structure if it is instead desired to transport metal panels to the apparatus.

According to the invention the hemming apparatus is constructed using standardized hemming modules. This has the further advantage of allowing for low cost manufacturing as well as design flexibility to fit various hem profiles. The hemming apparatus can carry a complete die set required for both pre and final hemming operations for a specific metal panel style. Alternatively, the hemming apparatus can carry a mixed die set, thus allowing

for hemming and pre-hemming of various metal panel styles. The hemming apparatus is powered with one or more pneumatic spring drives. This powering method has the advantage of eliminating the need for expensive, complicated, and heavy alignment mechanisms and structures as well as greatly reducing maintenance costs associated with traditional guide mechanisms, air cylinders, and especially hydraulic systems.

More specifically a portable hemming apparatus in accordance with the invention includes a support structure to which modular hemmers and pneumatic drives are attached. Each modular hemmer includes a fixed hem die holder, a hem die attached to the hem die holder and a movable hem punch. Hemmer operators are operatively connected to the modular hemmers by a lever arm assembly. Actuation of the pneumatic drive moves the hemmer operator which correspondingly closes and opens the hem punch in relation to the hem die, causing the desired hemming to take place.

These and other features and advantages of the invention will be more fully understood from the following detailed description of the invention taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a partial perspective view of a portable hemming apparatus according to the invention illustrating a retracted position of the apparatus;

FIG. 2 is a partial perspective view of the portable hemming apparatus illustrated in an extended hemming position of the apparatus;

FIG. 3 is a perspective view of a complete portable hemming apparatus according to the invention in the retracted position;

FIG. 4 is a plan view illustrating one distinct arrangement of hemmer modules that forms part of the present portable hemming apparatus;

FIG. 5 is another plan view illustrating another distinct arrangement of hemmer modules that forms part of the present portable hemming apparatus;

FIG. 6 is yet another plan view illustrating another distinct arrangement of hemmer modules that forms part of the present portable hemming apparatus;

FIG. 7 is a perspective view illustrating a portable hemming apparatus in accordance with the invention mounted to a robot arm;

FIG. 8 is an environmental perspective view of portable hemming apparatus of FIG. 7 mounted to a robot arm approaching a metal panel;

FIG. 9 is an environmental perspective view of portable hemming apparatus of FIG. 7 mounted to a robot arm and nearly in position with respect to the metal panel, while the pre-hem die set of the apparatus is oriented towards the metal panel;

FIG. 10 is an environmental perspective view of the portable hemming apparatus of FIG. 7 mounted to a robot arm in working position with respect to the metal panel, while the pre-hem die set of the apparatus is oriented towards the metal panel;

FIG. 11 is an environmental perspective view of the portable hemming apparatus mounted to a robot arm nearly in position with respect to the metal panel, while the apparatus is rotated so that the final hem die set of the apparatus is oriented towards the metal panel;

FIG. 12 is an environmental perspective view of the portable hemming apparatus of FIG. 7 mounted to a robot arm in working position with respect to the metal panel, while the final hem die set of the apparatus is oriented towards the metal panel;

FIG. 13 is an environmental perspective view of a portable hemming apparatus in accordance with the invention mounted to a pedestal stand with a metal panel being transported towards the apparatus;

FIG. 14 is an environmental perspective view of the portable hemming apparatus of FIG. 13 mounted to the pedestal stand nearly in position with respect to the metal panel, while the pre-hem die set of the apparatus is oriented towards the metal panel;

FIG. 15 is an environmental perspective view of the portable hemming apparatus of FIG. 13 mounted to the pedestal stand in working position with respect to the metal panel, while the pre-hem die set of the apparatus is oriented towards the metal panel;

FIG. 16 is an environmental perspective view of the portable hemming apparatus of FIG. 13 mounted to the pedestal stand nearly in position with respect to the metal panel, while the final die set of the apparatus is oriented towards the metal panel; and

FIG. 17 is an environmental perspective view of the portable hemming apparatus of FIG. 13 mounted to the pedestal stand in working position with respect to the metal panel, while the final die set of the apparatus is oriented towards the metal panel.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings in detail, numeral 20 generally indicates a portable hemming apparatus comprising a support structure 1, a plurality of modular hem die holders 2 attached to the support structure 1, and a corresponding plurality of hem punches 5, 15. A corresponding plurality of hem dies 3, 14 is mounted to the hem die holders 2. The hem punches 5, 15 are operatively connected to lever arms 4 which can freely rotate about pivots 7 mounted in the hem die holders 2. Moveable engagement members 6 fixed in the lever arms 4 rest on a roller plate 8, such roller plate 8 being attached to a first air spring drive 9. The first air spring drive 9 is connected to the support structure 1 on the side opposite the roller plate 8.

Figs. 1 and 3 show the hemming apparatus 20 in a retracted position while Fig. 2 shows the hemming apparatus 20 in an extended hemming position. The hemming apparatus 20 is at rest in the retracted position. When fluid power is applied to the first air spring 9, it expands and forces the roller plate 8 away from the support structure 1. The roller plate 8 is moveable in a range that is bounded by a stop plate 13 on the end farthest from the support structure 1. The roller plate 8 ceases to move away from the support structure 1 when a roller plate cap 10 contacts the stop plate 13. The stop plate 13 is fixed to the die holders 2 by shims 12 that allow for adjustment of the stop position. The expansion of the first air spring 9 simultaneously forces the rollers 6 away from the support structure 1, causing the lever arms 4 to rotate about the pivots 7 and to close the hem punches 5, 15 onto the hem dies 3, 14. In this position, the hemming apparatus 20 is fully extended.

A second, smaller air spring drive 11, attached on its outer end to the stop plate 13, acts to return the hemming apparatus 20 to the retracted position by bearing on the roller plate 8 and attached roller plate cap 10, forcing the roller plate 8 back towards the support structure 1. The moveable engagement members 6, being trapped between the roller plate 8 and the roller plate cap 10, are simultaneously forced toward the support structure 1. This causes the lever arms 4 to rotate about the pivots 7, and the hemming apparatus 20 is returned to the retracted position.

Figs. 4, 5 and 6 show examples of arrangements of modular hemmers 27. Varying the number and orientation of the modules as shown by example in Figs. 4-6 allows for the hemming of many

different shapes of metal panels. Further, varying the number and orientation of the air spring(s) 9 in Figs. 1-3 and the size and shape of the support structure 1 and roller plate 8 in Figs. 1-3 also allows for hemming of many different types of metal panels with varying profiles, including, but not limited to, body side wheel openings, fender openings, window openings, sun roof openings, and entire closure panels.

Figs. 7-12 show a method of operation of the hemming apparatus 20 when the apparatus is mounted to a robot arm 21. Fig. 7 shows the hemming apparatus 20 mounted to a robot arm 21. In Fig. 8, the robot arm 21 moves the hemming apparatus 20 towards a metal panel 22. In Fig. 9, the robot arm 21 has moved the hemming apparatus 20 nearly in position with respect to the metal panel 22. The pre-hem die set 23 is oriented towards the metal panel 22, which is the operating orientation. The final hem die set 24 is oriented away from the metal panel 22. In Fig. 10, the pre-hem die set 23 of the hemming apparatus 20 is in working position with respect to the metal panel 22. The hemming apparatus 20 can then be cycled as described in Figs. 1-3 to complete the pre-hem operation. In Fig. 11, the hemming apparatus 20 has moved to a clearance condition with respect to the metal panel 22 and the robot arm 21 has rotated the hemming apparatus 20 180 degrees so that the final hem die set 24 is oriented towards the metal panel 22 for operation on the panel. In Fig. 12, the final hem die set 24 of the hemming apparatus 20 is in working position with respect to the metal panel 22. The hemming apparatus 20 can then be cycled as described in Figs. 1-3 to complete the final hem operation. The robot then transports the hemming apparatus 20 away

from the metal panel 22, returning to the orientation shown in Fig. 8.

Figs. 13-17 show a method of operation of the hemming apparatus 20 when the apparatus is mounted to a pedestal stand 25. In Fig. 13, the metal panel 22 is transported to the hemming apparatus 20 by means of a gripper 26 mounted to a robot arm 21. The hemming apparatus 20 is mounted in such a way that the pre-hem die set 23 is facing upwards away from the base of the pedestal 25 while the final hem die set 24 is facing down towards the base of the pedestal 25. In Fig. 14, the metal panel 22 is nearly in position with respect to the hemming apparatus 20 and the metal panel 22 is oriented for pre-hem operation. In Fig. 15, the metal panel 22 is in working position with respect to the pre-hem die set 23. The hemming apparatus 20 can then be cycled as described in Figs. 1-3 to complete the pre-hem operation. In Fig. 16, the metal panel 22 is nearly in position with respect to the hemming apparatus 20 and is oriented for the final hem operation. In Fig. 17, the metal panel 22 is in working position with respect to the final hem die set 24. The hemming apparatus 20 can then be cycled as described in Figs. 1-3 to complete the final hem operation. The robot arm 21 then transports the metal panel 22 away from the hemming apparatus 22, returning to the orientation shown in Fig. 13.

Although the invention has been described by reference to specific embodiments, it should be understood that numerous changes may be made within the spirit and scope of the inventive concepts described. Accordingly, it is intended that the invention not be limited to the described embodiments, but that it have the full scope defined by the language of the following claims.